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AI Can Revolutionise Education but Technology Is Not Enough: Human Development Meets Cultural Evolution

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ABSTRACT

Artificial Intelligence could dramatically boost educational outcomes and close gaps – but only if policymakers take a human-centred, systems-level approach to AI integration. Cultural evolution, the science of how beliefs, values, norms, technologies and institutions evolve over time, offers a framework for understanding the promises and pitfalls of different approaches to AI in education policy. Using this perspective and drawing on comparative evidence from Estonia's successful "Tiger Leap" initiative and the failed "One Laptop Per Child" (OLPC) programme, we identify three missteps that derail national strategies: (1) techno-fix thinking, (2) weak infrastructure and teacher support and (3) lack of local adaptation. Uruguay's Plan Ceibal is a notable exception to OLPC's general failures, revealing why technology alone is not enough. We map AI's headline promises – personalised tutoring, higher teacher productivity, smaller equity gaps – onto the specific capabilities each can expand, and we highlight three systemic risks: digital exclusion, algorithmic bias and widening inequalities. Synthesising these lessons, we propose a practical roadmap. AI will revolutionise education and enhance human development only insofar as it is embedded in human centred systems that grow everyone's capabilities and freedom to learn, create and participate in society.

KEYWORDS

Artificial intelligence; education policy; capabilities approach; cultural evolution; personalised learning; algorithmic bias

Introduction

Radio, television, computers, the internet and social media all transformed education and society, but AI represents a more radical shift than these previous technologies. AI does not merely transmit information. Nor does it merely support some aspects of cognition, as calculators, word processors, or spelling

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and grammar checkers do. Generative AI and large language models in particular are active, agentic participants in cognition itself, more akin to an easily accessible, if somewhat unreliable, expert available at all times. The question is no longer whether students will use AI – the vast majority already do (86% according to a Digital Education Council 16 country survey[1]) – but how to integrate AI in ways that empower learners and educators rather than limiting their agency. From a human development perspective, this means focusing on whether AI expands people's real freedoms to think, learn and live the lives they value (Sen 1999). While AI can enhance functionings – valuable activities and achievements, such as writing faster and solving problems more efficiently, it must also support the expansion of capabilities – the genuine opportunities and freedoms to achieve those functionings – and agency – the power to act on those opportunities in the pursuit of their goals (Nussbaum 2011). When a radically new technology emerges, such as the steam engine, electricity, nuclear power, or the internet, the past can only be a guide – we require first principles thinking and a framework for understanding how societies change. AI could prove as disruptive as the Industrial revolution, dangerous as nuclear weapons and is already reshaping how we work and interact faster than the internet and social media did.

A cultural evolutionary perspective provides a guiding framework to navigate AI's role in education. Cultural evolution examines how ideas and technologies are learned, adapted, and transmitted against the backdrop of societal norms and institutions (Muthukrishna 2023). This helps us assess the systemic and long-term effects of AI integration: innovations succeed not just because they work, but because they fit into a culture and evolve through social adoption. Linking the capabilities approach with cultural evolution is valuable because it bridges individual empowerment with collective adaptation. The interdisciplinary lens we propose asks both "Does this AI intervention expand the real freedoms and agency of learners and ultimately all members of society?" and "Will this intervention be selected for and sustained within the cultural and institutional environment?". By combining these frameworks, we can better shape AI in education in ways that actually improve human development – expanding what people are able to do and to be – and how it can be steered to fit local values and needs. In short, AI's impact on education must be evaluated not by the capabilities of the technology, but by the human capabilities it expands and the cultural context it evolves within. We start by understanding education itself from a cultural evolutionary perspective.

What is Education and How Does it Change Cognition?

The nature of education and the skills we value have always co-evolved with technology. The instant accessibility of knowledge through the Internet has reduced the value of simply memorising large quantities of information and increased the value of sorting the signal from the noise, finding relevant knowledge,

interpreting data and maintaining focus in a noisy world filled with distractions (Sparrow, Liu, and Wegner 2011). The majority of jobs we have today did not exist before 1940 (Autor et al. 2024). AI's growing role means we need to consider what skills and knowledge are actually valuable in a world of ubiquitous AI. For example, if a large language model can draft an essay, *what you want* to say may matter more than *how you want to say it*. If a more sophisticated computer algebra system can discover new proofs (Romera-Paredes et al. 2024) or an AI can automate aspects of scientific discovery (Wang et al. 2023), then domain knowledge of the most important problems and how they might be solved becomes more important than the mechanics of solving them.

As AI continues to mediate education experiences and reshape society, we must revisit the capabilities needed in this new context. Just as the introduction of schools reduced spatial navigation abilities in Bolivian children (Davis and Cashdan 2019), the increased use of computing devices for AI-mediated learning may affect child development. Access to AI tools may shift emphasis away from rote memorisation and basic recall, instead elevating the value of interpretive reasoning, critical evaluation and adaptive problem-solving. While this shift could empower some students with greater cognitive flexibility, it also raises concerns about overdependence on AI in ways that harm learning and independent reasoning processes. In other cases, we likely don't want AI to reshape certain aspects of development, particularly physical, social and emotional development. If, for example, children spend more time interacting with machines than peers or teachers, this may harm their very ability to participate in society.

Strategic AI Integration into Education

AI's arrival in classrooms comes with lofty promises: personalised one-on-one tutoring for every student, automated grading that frees teachers' time, intelligent tutoring systems to pinpoint learning gaps and adaptive content tailored to each learner's level and interests. These innovations could expand several human capabilities if implemented thoughtfully. For example, AI-powered personalised learning can give each student a unique pathway – revisiting tough concepts, accelerating through areas of strength and discovering new interests. In a class of thirty, AI could help enable thirty individualised learning paths, potentially expanding each learner's agency and mastery by allowing them to progress at their own pace. AI as a teacher's aide can handle rote tasks (like drafting feedback or grading quizzes) and analyse student performance data, freeing teachers to focus on mentoring and creative instruction. In this "force multiplier" role, AI extends educators' reach while leaving professional judgment in human hands – ideally enhancing teachers' capability to support diverse learners. AI can also enable continuous feedback and assessment, giving students immediate, tailored feedback and providing teachers with real-time diagnostics. Scaling up the kind of formative feedback once only

available to those who could afford one-on-one tutoring, AI could promote more equitable outcomes. Moreover, AI tools can increase the inclusivity and accessibility of education: text-to-speech, machine translation and content generation can make lesson materials available in any language or modality (audio, visual, sign language), helping overcome geographic, linguistic, or disability-related barriers. By enlarging each learner's freedom to access knowledge past individual barriers, AI has the potential to democratise learning and expand the capabilities of students who might otherwise be left behind.

In essence, AI – if deployed with a human-centred, capability-expanding approach – can help education systems fulfil the expansion of "real freedoms" that define human development. It can empower each child not just to attend school, but to truly flourish in their learning and become whomever they aspire to be.

Pitfalls of AI in Education

For all its promise, AI in education also carries significant risks that, if left unaddressed, could constrain or even shrink the capabilities of learners and teachers. The guiding questions must be: Do AI-driven practices protect and enhance human agency, or do they erode it? Do they promote equity, or exacerbate inequalities? Do they respect students' and teachers' dignity and voice? Without careful design, AI could undermine student agency – for example, if AI spoon-feeds children solutions or is biased towards content trained on a largely Western dataset, it can create dependence and subtly shape values, norms and aspirations. The hallucination of false information is a new form of the old concern about unreliable sources now coming from a confident, authoritative AI. Algorithmic bias is another concern: a personalised learning app might subtly steer boys towards STEM activities more than girls, due to unconscious bias in its algorithm. There are also concerns about privacy and surveillance – AI systems that collect detailed data on student performance or behaviour could be misused, compromising students' rights and creating a climate of monitoring that stifles the freedom to fail and learn. Additionally, heavy reliance on AI might harm teachers and ultimately learning if administrators see AI as a way to cut costs on human educators. And finally AI could widen inequalities if cutting-edge AI education technologies reach only well-funded schools and wealthy countries.

OpenAI's ChatGPT was the fastest-growing application in history. Today, AI is ubiquitous. The task now is to catch up: to formulate policies that ensure AI is a boon for human development. That means placing ethical safeguards (protecting rights to privacy, equality and agency), ensuring inclusive access (so AI doesn't become a luxury good), and keeping the focus on human empowerment (training teachers and students to wield AI for their own purposes, not be controlled by it).

Global Policy Innovations

As of today, there are no examples of long-term outcomes for AI integration into education, especially since even in the last 6 months, there have been significant advances in the frontier foundation models, rendering prior research obsolete for describing current AI's capabilities for education. Early evidence for technology aid instruction (Muralidharan, Singh, and Ganimian 2019) and a recent meta-analysis (Wang and Fan 2025) suggest the possibility of substantial gains, especially in more deprived contexts. But these possibilities should be tempered by other studies show GPT-based tutors can improve performance, but create dependence and harm learning without access to AI (Darvishi et al. 2024).

In the absence of long-term AI-specific case studies, to offer policy recommendations for what has worked and what has not worked, we will draw on: (1) the successful case of Estonia's Tiger Leap technology revolution, (2) the failed case of One Laptop Per Child and (3) the singular standout success of Uruguay's approach to One Laptop Per Child. Together these reveal several important lessons for policymakers.

Case Study 1. Estonia to E-stonia: A Model for Digital Transformation

Estonia's Tiger Leap[2] catapulted the post-Soviet nation from 50% of people without a telephone to 100% connected schools, weaving coding and collaborative digital problem-solving into everyday learning. Within two decades, Estonia had the highest PISA scores in the Western world, Europe's leader in attracting tech investment[3], and the most unicorn companies per capita on the planet.[4] They achieved this by taking a human-centred approach to technological integration. This approach fostered the opportunity to turn access into real capabilities – providing students with the skills needed to meaningfully use technology in ways that support learning. Building on this foundation, the AI Leap 2025 strategy now aims to make Estonia a global leader in AI education, including personalised learning systems, open-source tools for teachers and AI literacy in their core curriculum.

Case Study 2. One Laptop Per Child: Lessons from an EdTech Tragedy

One Laptop Per Child (OLPC) was a stark contrast to Estonia's Tiger Leap – it assumed that a cheap rugged laptop would empower learning around the world, but without a human centred approach with support for teachers, curriculum, local infrastructure, and culturally localised software, billions were wasted with no educational gain to show for it. The technology alone isn't enough[5]; students did not have the real freedom to take advantage of the opportunity as they lacked the skills to reap the benefits.

The successful exception to this broad failure was Uruguay's Plan Ceibal, which shared many features of Estonia's Tiger Leap.

Case Study 3. Uruguay's Plan Ceibal: Human-Centred Digital Equity

Uruguay's Plan Ceibal treated the OLPC laptop as just one component of a long-term capability-expansion scheme: build infrastructure, train teachers, supply local content and keep iterating under a dedicated agency insulated from political churn. That human-centred, systems approach with a focus on equity – rather than the "drop boxes of hardware and hope for the best" model – delivered measurable learning gains, high usage rates and lasting public approval while most other One Laptop per Child projects failed.[6]

What can we learn from these case studies to guide global AI in education policy?

Misstep 1: The Overemphasis on Technology Alone

The OLPC programme was built on the assumption that simply providing access to technology would revolutionise education. In contrast, Estonia's Tiger Leap and Uruguay's Plan Ceibal introduced computers and other digital tools early alongside a well-structured, localised curriculum and teacher training programme, developed or co-developed with teachers. Technology alone does not educate; it must be embedded into a broader pedagogical and institutional framework. Early evidence suggests that AI can both help and harm learning, depending on how it is used.

Misstep 2: The Failure to Address Infrastructure and Support

Estonia and Uruguay's digital transformation succeeded because it tackled multiple dimensions simultaneously, considering the system as a whole – ensuring widespread internet access, teacher training and policy alignment. OLPC, by contrast, often distributed laptops to schools without stable electricity, internet access, or proper maintenance support. In some cases, the laptops broke down, with no local expertise to repair them.

This failure mirrors a broader challenge in AI adoption today: some countries rushing to implement AI-based education without first ensuring:

1. reliable electricity
2. fast internet connectivity
3. functional and modern computing devices
4. technical training and digital literacy of teachers and students
5. access to the frontier foundation AI models or customised AI intelligent tutoring systems

Successful innovations tend to have good fit with local environments, complemented by sufficient digital infrastructure, institutional support and teacher capacity, which enable the newly integrated technology to evolve within the system. International organisations like UNESCO, OECD, USAID and the World Bank can play a crucial role in supporting low and medium HDI countries to reap the benefits of AI through tech transfers, grants and assistance (Khan, Umer, and Faruqe 2024). If these barriers are not overcome, AI cannot be used to bridge development and innovation disparities.

Misstep 3: The Lack of Local Adaptation and Cultural Fit

Another key mistake of OLPC was its one-size-fits-all approach. The laptops were designed by MIT engineers with minimal input from educators in the countries receiving them. They contained preloaded educational content that was often disconnected from local curricula and languages. In these cases, students lack the capability to meaningfully engage with AI, no matter how advanced the tools.

By contrast, Estonia's Tiger Leap and Uruguay's Plan Ceibal designed their digital transformation in partnership with local educators and policymakers, ensuring alignment with national learning goals ensuring localisation. AI-enhanced education would be better served by following the models offered by Estonia and Uruguay rather than OLPC's tech-fix approach, embedding AI tools within local pedagogical practices, co-creating curricula to ensure cultural adaptability, and empowering teachers rather than assuming AI can replace them.

Policy Recommendations

To say that usage of AI is growing usage among students and educators is an understatement, but how institutions may choose to adopt AI is a choice. A human-centred approach is emerging in academia (Brinkmann et al. 2023) and must also be implemented in policy if AI in education is to expand human capabilities and human development. Policymakers, educators and developers each have roles to play in this direction. Here we distil five key recommendations that emerge from the approach presented in this paper.

1. ***Adopt a Human Development Framework:*** Ministries of Education should explicitly frame their ed-tech strategies around human development outcomes (e.g. critical thinking, creativity, civic engagement, well-being) rather than just tech roll out and adoption. This means setting goals like "AI will be used to personalise learning to ensure every child gains foundational skills and confidence" or "use AI to free teacher time for mentorship and socio-emotional support", rather than "20,000 schools now have access to ChatGPT Education".

2. ***Ensure Equity of Access is Non-Negotiable:*** Governments must treat digital infrastructure (devices, connectivity) and AI access as essential components of the right to education in the twenty-first century. Public investment or subsidies will often be needed to connect rural schools, provide hardware for low-income students, and maintain open-access AI tools. Global cooperation can help here; for instance, international donors or development banks might fund connectivity in least-developed regions as part of achieving SDG 4. Additionally, accessibility must extend to localisation of content: multilingual AI and culturally relevant curricula. This is to ensure that all students have the practical means to develop the skills and knowledge required to benefit from AI tools – enhancing their capability.
3. ***Build AI Literacy and Teacher Capacity:*** Teachers need professional development to understand AI tools, trust them, and integrate them effectively. This training should not just be technical, but also pedagogical and ethical – helping teachers learn when and how to use AI, and when not to. Likewise, students should be taught about AI as part of the curriculum: its benefits, pitfalls and basic functioning. This empowers students to use AI critically and creatively, turning them from passive consumers into active agents. National curricula may need updating to include AI concepts in computing or science classes, and cross-curricular projects on AI ethics in society. Delivering "how to use AI safely, ethically and effectively" alongside access to frontier foundation models is critical. Contrary to the common perception of AI integration reducing the demand for teachers, we argue that teachers are a necessary channel to promote safe, ethical, and effective adoption of AI. AI may or may not take educators jobs, but the teacher who knows how to use AI probably will; the demand for educators who know how to use AI to enhance educational outcomes is likely to increase.
4. ***Embed Ethical Guidelines and Regulations:*** Policymakers should establish clear rules for AI use in education that protect students' rights and well-being. This includes data privacy laws (e.g. banning sale or misuse of student data collected by EdTech), algorithmic transparency requirements (so that AI decisions can be explained and challenged), and bias audits for any high-stakes algorithm (such as university admissions tools or personalised learning systems that might inadvertently track students into different paths). Students should always have a way to appeal or discuss decisions made by AI (like grading outcomes); and that the school will periodically survey students and parents about their comfort with AI practices. By making values such as these explicit, it builds trust and prevents harm, allowing AI integration policies to culturally evolve in alignment with local values and educational practices.
5. ***Foster Participatory Implementation:*** Involving those affected in decisions isn't just about voice, it's also about taking a cascade approach to changing systems. Schools and developers should involve teachers, students, and

parents in the planning and rollout of AI initiatives. This could take the form of consultations, pilot programs with feedback loops, and iterative design. For example, before scaling an AI technology and curriculum (which should go hand in hand) nationally, a ministry might pilot it in a subset of schools to answer questions such as: Did students and teachers find it helpful? Did it make them feel more capable or more frustrated? To embed this in a cultural evolutionary approach that allows practices to evolve, we need to use a "fail locally, learn globally" strategy. Empower and incentivise teachers to try different approaches and also to share what is learned among all teachers. One advantage of AI is that it can make these processes more efficient by self-documenting student usage and performance and summarising best practices. Compared to previous educational interventions, AI technologies themselves may decrease evaluation timelines.

Conclusion

AI holds the potential to revolutionise education, but only if guided by a human-centred approach, with opportunities to personalise learning, support teachers and expand access. Yet, technology alone is not enough. A cultural evolutionary perspective helps us understand why: educational innovations succeed not just when they are introduced, but when they are adapted to and transmitted through institutions, norms and local learning environments.. Success depends on embedding AI within systems that prioritise infrastructure, teacher training and cultural fit. Previous examples show that tech-first approaches like OLPC fail without these supports, while Estonia and Uruguay succeeded by integrating technology into broader national strategies, focusing on supporting the development of human capabilities – for instance, providing students with adequate AI literacy. Key risks such as digital inequality, algorithmic bias, privacy concerns and the erosion of teacher roles require proactive mitigation and cultural-adaptive design. Policymakers must act fast to ensure AI strengthens rather than weakens capabilities. Innovations in AI are moving faster than innovations in policy so the stakes are high – but so too is the potential.

Notes

1. https://www.digitaleducationcouncil.com/post/digital-education-council-global-ai-student-survey-2024
2. https://www.educationestonia.org/wp-content/uploads/2023/01/tiigrihype2007ENG_standard.pdf
3. https://sifted.eu/articles/cee-vc-booming-report
4. https://www.euronews.com/business/2024/09/23/the-big-question-estonia-has-the-most-tech-unicorns-per-capita-in-europe-whats-their-secre
5. https://www.unesco.org/en/digital-education/ed-tech-tragedy

6. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099038209252435210/idu1120af84019d6814ceb1b76717c9bcf6bbc5d

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